



TIMES demo models

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TIMES demo models

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EFDA-TIMES and ETSAP-TIAM Workshop
DTU Risø Campus, Roskilde, Denmark

back-to-back with

64th Semi-annual ETSAP meeting, Seoul, Republic of Korea

Program continuing in Denmark with Skype connection to remote participants

Overview

- Survey of TIMES demo models
 - **VEDA-TIMES demo v.48**: shipped with VEDA for test of new installations and updates
 - **TIMES_tutorial**: very small model for starters
 - **7-step tutorial**: used for training, Cape Town 2010 and later
 - **KanOrs-EMR library / VEDA forum**
- Time slices for energy demand and variable generating units
- Further development: SubRES and generic regions

VEDA-TIMES demo v.48

■ Sectors

- Electricity
- Industry
- Supply
- Transport
- Other

| | | | | | | | | | | | | | | |
|---|----------------------------------|---------------------------------------|-----------|----------|-----------|-------------|-----------|-------------|--------|---------|----------|------|-------|--------|
| * declare and characterize the electric generating plants | | | | | | | | | | | | | | |
| Existing electricity power plants | | | | | | | | | | | | | | |
| Sets | TechName | *TechDesc | Comm-IN | Comm-OUT | CommGrp | Input | Share-LO | CEFF | CEFF-C | CEFF-OA | CEFF-HAR | EFF | S_EFF | Output |
| ECOASTM000 | EPLT.CO.A Steam Turbine.Existing | COAHAR | ELC | | | | | | | | | 0.42 | | |
| * declare and characterize the industrial technologies | | | | | | | | | | | | | | |
| Existing technologies for finished iron and steel production | | | | | | | | | | | | | | |
| Comment and declaration override | TechName | TechDesc | Comm-IN | Comm-OUT | | Consumption | Stock | Life | FIXOM | | | | | |
| * Unit | | | | | | Mt | Years | Eur/ton | | | | | | |
| IISFINPRO00 | IIS.Finishing Processes.00 | MISCST | IIS | | | 1 | 230 | 30 | | | | | | |
| | | COAHAR | | | | 0.2 | | | | | | | | |
| * define and characterize the domestic resource supply options | | | | | | | | | | | | | | |
| Non renewable energy reserves | | | | | | | | | | | | | | |
| TechName | TechDesc | Comm-OUT | CUM-WEU | CUM-ROW | COST | COST-2050 | BNDACT-UP | BNDACT-UP | | | | | | |
| End-Use | | | | | | | | | | | | | | |
| * Unit | | | | | | | | | | | | | | |
| IIS | MINOILCRD1 | Crude Oil - Located reserves - Step 1 | OILCRD | 99999999 | 199999998 | 4.00 | | | | | | | | |
| * declare and characterize other automobile demands | | | | | | | | | | | | | | |
| Existing Cars | | | | | | | | | | | | | | |
| TechName | TechDesc | Comm-IN | Comm-IN-A | Comm-OUT | CEFF | Input | Cap2Act | ACTFLO-DEMO | AF | Life | Stock | | | |
| | | | | | | | | | | | | | | |
| CARGSL00 | | | | | | | | | | | | | | |
| * declare and characterize other demands (Agr/Comm/Resid) and their process | | | | | | | | | | | | | | |
| CARELC000 | | | | | | | | | | | | | | |
| Existing technologies for other trans | | | | | | | | | | | | | | |
| TechName | *TechDesc | Comm-IN | Comm-OUT | EFF | Share-FX | Share-FX | Share-UP | Share-UP | | | | | | |
| | | | | | ~WEU | ~ROW | ~2001-W | ~2001-R | | | | | | |
| RCATEC00 | RCA Other Sectors.00 | OILLPG | | 1.00 | 0.034 | 0.019 | 0.038 | 0.021 | | | | | | |
| | | OILGSL | | | 0.002 | 0.001 | 0.002 | 0.001 | | | | | | |
| | | OILKER | | | 0.064 | 0.035 | 0.070 | 0.039 | | | | | | |
| | | OILDST | | | 0.192 | 0.106 | 0.211 | 0.117 | | | | | | |
| | | ELC | | | | | | | | | | | | |
| | | HETH | | | 0.049 | 0.043 | 0.054 | 0.047 | | | | | | |
| | | GASNAT | | | 0.283 | 0.194 | 0.311 | 0.214 | | | | | | |
| | | COAHAR | | | 0.008 | 0.043 | 0.008 | 0.043 | | | | | | |
| | | OILCRD | | | 0.000 | 0.000 | 0.000 | 0.000 | | | | | | |
| | | BIOFUE | | | 0.105 | 0.325 | 0.116 | 0.358 | | | | | | |
| | | OTH | | | | | | | | | | | | |
| ~FI_T,DEMAND | | | | | | | | | | | | | | |
| CommName | | WEU | ROW | | | | | | | | | | | |
| *UNITS | | PJ | PJ | | | | | | | | | | | |

TIMES_TUTORIAL

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

| REG1 | Unit | Quantities (in unit) | | Cost (in M2000/Unit) | |
|----------------------------|-------|----------------------|-------------|----------------------|-------------|
| | | 2000 | 2001-2 ave. | 2000 | 2001-2 ave. |
| Demand of TPES | EJ | 15 | 16 | 1.00 | 1.16/0 |
| Domestic | EJ | 9/12 | | 4.90 | 4.04 |
| Import of OILCRD | EJ | unbounded | unbounded | 5.00 | 6.00 |
| Emission permits, purchase | MCO2 | unbounded | unbounded | | |
| Consumers' device | E/J/a | Efficiency (decimal) | | Cost (in M2000/unit) | |
| | | 1 | 1.0/1.30 | 10 | 10/12.25 |

| Emissions (kgCO2/GJ) | |
|----------------------|----|
| Crude oil extraction | 10 |
| Crude oil combustion | 70 |

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

F7 =Balance!F8

* define and characterize the domestic resource supply options

Fossil reserves ~FL_T

| TechName | TechDesc | Comm-OUT | CUM | COST | COST-2001 | BNDACT-UP | BNDACT-2001-UP | ENV_ACT |
|------------|--------------------------------|----------|---------|------|-----------|-----------|----------------|------------|
| U: | | [PJ] | [M€/PJ] | | | [PJ] | | [ktCO2/PJ] |
| MINOILCRD1 | Crude Oil domestic extraction | OILCRD | | 1.00 | 1.10 | 10000 | 9000 | 10 |
| MINOILCRD2 | Crude Oil potential extraction | OILCRD | | | 6.00 | 0 | 3000 | 10 |

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

B2b

~FL Process

| Sets | TechNam | TechDesc | Tact | Tcap | Tslvl | PrimaryC | Vintage |
|------------------|---------------|----------|------|------|-------|----------|---------|
| SRCENCI EXPCO2N | Emissions kt | | | | | NO | |
| SRCENCI IMPOILCR | Import of CPJ | | | | | NO | |
| SRCENCI MINOILCR | Crude Oil PJ | | | | | NO | |
| SRCENCI MINOILCR | Crude Oil PJ | | | | | NO | |
| TCH DMD TECTPES | Base year PJ | | | PJa | | NO | |
| TCH DMD TECTPES | New Dema PJ | | | PJa | | NO | |

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

E21

Associate the emissions with consumed commodity

~COMEMI

| CommName | OILCRD |
|----------|--------|
| CO2N | 70 |

All emissions are in kt

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

H15

* Declare and characterize demand and demand technology

Existing demand technology ~FL_T

| TechName | TechDesc | Comm-IN | Comm-OUT | EFF | INVCOST | LIFE | START |
|----------|----------------------------|---------|----------|------|---------|------|-------|
| TECTPES1 | Baseyear Demand technology | OILCRD | TPES | 1.00 | 10 | 3 | |
| TECTPES2 | New Demand technology | OILCRD | TPES | 1.30 | 12.25 | 3 | 2001 |

| CommName | DEMAND/2000 | DEMAND/2001 |
|----------|-------------|-------------|
| U: TPES | 15000 | 16000 |

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

D12

* define the commodities used in this workbook

Commodities - Supply

~FL Comm

| Csets | CommName | CommDesc | Unit | LimType | CTSLvl | PeakTS | CType |
|-------|----------|-----------------------------|------|---------|--------|--------|-------|
| NRG | OILCRD | Crude Oil | PJ | | | | |
| DEM | TPES | Total primary energy supply | PJ | | | | |
| ENV | CO2N | CO2 emission | kt | | | | |

VT_TT_SUP_V1p0.xls [Compatibility Mode] - Microsoft Excel

G9

* define and characterize the exogenous options

Exogenous Import ~FL_T

| TechName | TechDesc | Comm-IN | Comm-OUT | COST | COST-2001 |
|------------|---------------------|---------|----------|---------|-----------|
| U: | | [PJ] | | [M€/PJ] | [M€/PJ] |
| IMPOILCRD1 | Import of Crude Oil | | OILCRD | 4.90 | 4.04 |

7-step tutorial

- Step-by-step approach:
 - Supply curve
 - Supply + simple demand
 - Electricity generation
 - Electricity sophistication
 - Multi-regional approach
 - ...

| DEMO Models | | | | |
|---|------------------------|---|---|---|
| <p>We start with the energy balance of EU27 and focus on building a model with our standard splitting and naming conventions. The model starts with a simple supply curve feeding a single demand and grows into a model that uses incrementally new parameters and features that exist. The most important difference compared to the old approach is that VEDA features are revealed <u>when they are demanded</u> by the situation... so that the motivation and advantages are clear.</p> <p>A lot of attention will be paid to keep the results reasonable so that they can be used for illustrating policy analysis.</p> <p>Phase I - Module I (Base / intermediate TIMES features)</p> | | | | |
| Model/Step Number | Model/Step Name | Key Features | Parameters introduced | Notes/Messages |
| 1 | Supply Curve | Supply curve for coal: <ul style="list-style-type: none"> - 1 commodity (coal) - 3 Extraction technologies - 1 Import - 1 Export Final Coal projection | <ul style="list-style-type: none"> - STOCK - CUM - COST - COM_PROJ - ACT_BND - LIFE | Single region model, 2 periods model Simplified Energy Balance (by sector and primary energy) Supply curve with fixed demand Annual <u>Update</u> |
| 2 | Supply + simple demand | Supply side: <ul style="list-style-type: none"> - 4 commodities <ul style="list-style-type: none"> o Energy (oil and gas) o Residential Demand (gas cons) o Emission (CO2) - 9 processes <ul style="list-style-type: none"> o 9 extraction techs o Oil, Gas and Coal Import and Export o 4 End-use (2 existing and 2 new) gas and oil consumption | <ul style="list-style-type: none"> - EFF - INVCOST - ENV_ACT - AFA - START | - VT_<Workbook name>_<Sector>_<Version> - <u>Settings</u> |
| 3 | Electricity Generation | ELC <ul style="list-style-type: none"> - Oil - Coal | | The EUD demand flat to show extrapolation powerful ELC demand will grow. ELC is an energy commodity and not demand commodity!!! |

1/4

| Model/Step Number | Model/Step Name | Key Features | Parameters introduced | Notes/Messages |
|-------------------|-----------------|--|-----------------------|--|
| | | <ul style="list-style-type: none"> - <u>Ext</u> | | - VT_<Workbook name>_<Sector>_<Version> - <u>Settings</u> |

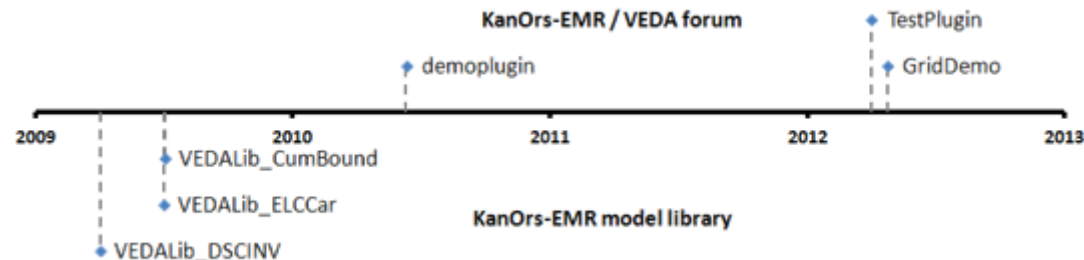
Existing demo models in KanOrs-EMR library / VEDA forum

■ KanOrs-EMR support/model library

- VEDALib_DSCINV: Discrete investments
- VEDALib_ELCCar: Electric car as night storage device
- VEDALib_CumBound: Cumulative bounds on import process

■ KanOrs-EMR / VEDA forum

- demoplugin: Plug-in hybrid EV as night storage device
- TestPlugin: 5 variants of plug-in electric cars
- GridDemo: Electricity grids with power flow equations



VEDALib_ELCCar

| Commodities | | | | | | | |
|---------------------------|----------------|-----------------------|------|---------------------------|-----------------|-----------------|-----------------------|
| ~FI Comm | | | | | | | |
| Csets | CommName | CommDesc | Unit | LimType | CTSLvl | PeakTS | Ctype |
| *Commodity Set Membership | Commodity Name | Commodity Description | Unit | Sense of the Balance EQN. | Timeslice Level | Peak Monitoring | Electricity Indicator |
| DEM | Heating | Heating Demand | PJ | | DAYNITE | | |
| | Cooling | Cooling Demand | PJ | | DAYNITE | | |
| | CarTravel | Travel By Car | PJ | | DAYNITE | | |

| ~FI Process | | | | | | | |
|---------------------------|-----------------|----------------------------|---------------|---------------|------------------------|-----------------|------------------|
| Sets | TechName | TechDesc | Tact | Tcap | Tslvl | PrimaryCG | Vintage |
| V: Process Set Membership | Technology Name | Technology Description | Activity Unit | Capacity Unit | TimeSlice Level of opm | Primary CommGrp | Vintage Tracking |
| DMD,NST | Car_ELC | Electric CAR - NST version | PJ | PJ-Yr | DAYNITE | | |

| ~FI T | | | | | | | | | | |
|------------------|-----------------|--------------|------------------|---------------|---------------------|---------------------|-----------------|--------------------|-------------------------|---------------------------|
| TechName | Comm-IN | TimeSlice | Comm-OUT | START | NSTTS | Life | INVCOST | STG_EFF | FLO_MARK ~CarTravel ~UP | FLO_MARK ~CarTravel ~UP-0 |
| *Technology Name | Input Commodity | TimeSlice(s) | Output Commodity | Starting Year | Charging TimeSlices | Lifetime of Process | Investment Cost | Storage Efficiency | Max Market Share | Mkt Share Extrapolate |
| Car_ELC | ELC | SN,FN,WN,RN | CarTravel | 2020 | 1 | 15 | 50 | 0.6 | 0.5 | 3 |

Timeslices

- Timeslice resolution in existing models

| Timeslice level / Model | DEMO | TIAM | PET | TIMES-DK |
|----------------------------|------|---------|------------|------------|
| Season | S, W | S, I, W | R, S, F, W | R, S, F, W |
| Weekly | | | | WD, NW |
| DayNite | D, N | D, N | D, N, P | A, D, C, B |
| Total number of timeslices | 4 | 6 | 12 | 32 |

- Electricity and heat demands are split into timeslices
- EV charging process vs Number of timeslices
- Demo models can serve as a first step towards understanding the potential role of EVs

Package of demos, tutorials - or models

All input files and Excel workbook for managing TIMES models

- Case names
- Select dd files
- Time slices

Operation

- Write run files
- Run GAMS model
- Store results

| Tut_00 | Tut_01 | TT_CapeTo wn_Demo | TT_Cape_T own_Step4 | TT_Cape_T own_Step5 | Tutorial_De mo6 | Tutorial_De mo6a | TT_Cape_T own_step_ 7 | 0 EC_start | HP1 | TIMES_DE MO | CO2Tax |
|-------------|-------------|----------------------|------------------------|------------------------|--------------------|---------------------|-----------------------------|-------------|-------------|----------------|-------------|
| BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| B-NewTechs | B-NewTechs | | | | | NEWTECHS | | REF | REF | DEM_REF | DEM_REF |
| | | | | CO2_BOUND | | NEWTECHS-VINTAGE | | ELCCAR | HEATPUMP | B-NewTechs | B-NewTechs |
| | | SysSettings | SysSettings | SysSettings | | STORAGE | SysSettings | SysSettings | SysSettings | | |
| | | | | | | NEWTECHS | | | | TRADEAttrit | TRADEAttrit |
| | | | | | | NEWTECHS-STORAGE | | | | | |
| IMP_Bound | IMP_Bound | | | TESTSCEN | TESTSCEN | TESTSCEN | NEWTECHS-VINTAGE | | | | |
| | | | | PKFLX | | | REFSCENARIO | | | | |
| | | | | RGASTEST | | | ELASTPAR | | | | |
| | CO2N_Bound | | | | CO2_BOUN | CO2_BOUN | ELC_CO2_BOUND | | CUMBOUNDS | | |
| | | | | PKFLX | PKFLX | PKFLX | PKFLX | | | | |
| | | | | RGASTEST | | | PKRSV | | | | |
| | | | | | | | TRA_CO2_BOUND | | | | |
| | | | | | | | TRADE_PARAM | | | | |
| | | | | | | | UC_CO2BND | | | UCTEST | UCTEST |
| | | | | | | | UC_GROWTH | | | | CO2Tax |
| SysSettings | SysSettings | | | | SysSettings | SysSettings | | | | SysSettings | SysSettings |
| | | | | | | VINTAGING | | | | | |
| ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL | ANNUAL |
| | | | S | S | S | S | S | S | S | S | S |
| | | | W | W | W | W | W | W | F | F | F |
| | | | SD | SD | SD | SD | SD | SD | W | W | W |
| | | | SN | SN | SN | SN | SN | SN | R | R | R |
| | | | WD | WD | WD | WD | WD | WD | SD | SD | SD |
| | | | WN | WN | WN | WN | WN | WN | SN | SN | SN |
| | | | | | | | | | FD | FD | SP |
| | | | | | | | | | FN | FN | FD |
| | | | | | | | | | WD | WD | FN |
| | | | | | | | | | WN | WN | FP |
| | | | | | | | | | RD | RD | WD |
| | | | | | | | | | RN | RN | WN |
| | | | | | | | | | | WP | WP |
| | | | | | | | | | | RD | RD |
| | | | | | | | | | | RN | RN |
| | | | | | | | | | | RP | RP |

SubRES and generic regions / further development

- EFOM 1999: Combined heat and power (CHP) in EFOM 1999
- EFDA-TIMES 2005: Nuclear fusion based on the Power Plant Conceptual Study
- EFDA-TIMES 2012: Update of the fuel cycle for nuclear fission
- TIMES-DK 2013: 32 time slices for demand variations and wind resources
- EV-STEP 2013-2014: Electric vehicles

Conclusion

| Technologies | Regional level | | | | | |
|--|----------------|--------|---------|---------------|------|---------------------|
| | World | Europe | Country | County/Region | City | Industry/ Campus |
| Electric vehicles | | | | | | |
| ... | | | | | | |
| Distributed small-scale electricity | | | | | | |
| ... | | | | | | |
| Large-scale electricity | | | | | | |

- Technologies described by SubRES
- Regions described by energy balance
- Testing of technology parameters combining regional level and sets of technologies

Downloads

- http://www.iea-etsap.org/web/docs/Files_Times_Tutorial.zip
- http://support.kanors-emr.org/ModelLib/VEDALib_ELCCar.rar
- http://support.kanors-emr.org/ModelLib/VEDALib_CumBound.rar
- http://support.kanors-emr.org/ModelLib/VEDALib_DSCINV.rar
- <http://support.kanors-emr.org/forum/uploads/30/GridDemo.rar>
- <http://www.kanors-emr.org/VedaSupport/forum/uploads/30/demoplugin.zip>
- <http://www.kanors-emr.org/VedaSupport/forum/uploads/30/TestPlugin.zip>